African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 110-124)
www.abjournals.org

COMMUNITIES' ADAPTATION STRATEGIES TO ENVIRONMENTAL CHANGES INDUCED BY GAS FLARING IN DELTA STATE, NIGERIA

Christiana Ovie Akpoduado

Department of Meteorology and Climate Change, Faculty of Environmental Management, Nigeria Maritime University.

Email: coakpoduado@gmail.com

Cite this article:

Akpoduado, C. O. (2024), Communities' Adaptation Strategies to Environmental Changes Induced by Gas Flaring in Delta State, Nigeria. African Journal of Environment and Natural Science Research 7(3), 110-124. DOI: 10.52589/AJENSR-3FPN217I

Manuscript History

Received: 19 May 2024

Accepted: 26 Jul 2024

Published: 9 Aug 2024

ABSTRACT: *The study assessed communities' adaptation strategies to environmental changes induced by gas flaring in Delta State, Nigeria. A structured questionnaire was administered to 738 respondents in direct proportion to the population size in fifteen sampled communities within ≤2.6km and 2.6-4 km radius of flare sites with a view to elicit information on adaptation strategies to gas flaring. Household heads were sampled in every third house along identified major streets in each community. The sets of data obtained were statistically treated using tables, simple percentages and principal components analysis (PCA). Data obtained from the field on adaptation strategies to gas flaring were used as variable inputs for principal components analysis (PCA). PCA was performed using the SPSS package version 20.0 for Windows; components were extracted using the principal component analytical method and extraction of significant factors was done with a minimum acceptable eigenvalue > 1 (Kaiser, 1958; Gaur & Gaur, 2006), by using the Kaiser's criterion. The age of respondents was 36±3.8 years, 59.0% were males, 38.5% earned <₦10, 000 monthly, 30.1% had post-secondary education and 28.3% were traders. Use of hand fans(82.9%), use of electric fans (78.6%), opening of windows and doors (70.8%), bathing frequently (67.7%), and taking shelter under trees (28%) were the major adaptation strategies to heat. Adaptation strategies to farming were late planting (76.6%), planting of fast maturing crop varieties (76.4%), increased land for production (65.3%), seasonal migration (42.2%) and use of fertilizer (35.4%). Gas flaring has impacted negatively on the people of the Niger Delta. There is a need to ensure that improved environmental standards are adopted to enhance the living conditions of the people.*

KEYWORDS: Communities, Adaptation strategies, Gas flaring, Environmental changes, Delta State.

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

INTRODUCTION

In Nigeria, gas flaring is a serious environmental problem that impacts on the livelihood of communities and biotic organisms around flare sites. For decades after the discovery of oil in commercial quantities in Nigeria, a significant percentage of the associated gas has flared with its inherent environmental consequences. Nigeria is acknowledged to flare 17.2 billion m^3 of natural gas per year in line with the exploration of crude oil in the Niger Delta. This high level of gas flaring is equal to roughly one quarter of the current power consumption of the African continent (Udok & Akpan, 2017). Several researchers have reported that Nigeria flares about 80% of natural gas produced during oil production (Ndinwa et al., 2020; Udok & Akpan, 2017; Oseh et al., 2015). In line with this, Uyigue and Agho (2007) stated that there are over 123 flaring sites in Nigeria and mostly in the Niger Delta region; this makes Nigeria to be recognized as the highest emitter of greenhouse gasses in Africa. Gas flaring which is the aftermath of oil exploitation has left the indigenous farm households of the communities in the Niger Delta region with less fertile farmlands and weakened the family and communal bonds causing social tensions among various groups and institutions (Ndinwa et al., 2020; Esu & Dominic, 2013).

Gas flaring has been theoretically banned in Nigeria since 1979 and the deadlines given for the ban to come to effect have been extended several times, but Nigeria still flares gas (Abdulkadir et al., 2019; Otiotio, 2013). The effects of gas flaring are multifaceted resulting in undesirable ecosystem disequilibrium. Odiong et al. (2008) stated that gas flaring contributes greatly to climate change, food insecurity, low income, loss of vegetation, and pollution of water bodies, among others. The location of some flare sites is an issue of concern and this has intensified the impacts of gas flaring on communities' livelihood around the flare sites. Available evidence reported that most of the flare sites are located within human settlement areas. Most of the flare sites are found in the Niger Delta region. For instance in Rumola, a community in Port Harcourt, Rivers State, Shell Company flares gas in the area and is about 300 meters from the nearest dwelling house (Udok & Akpan, 2017). For decades since the discovery of oil in Nigeria, humans have had to diversify several ways to adapt or cope with the inherent impacts of gas flaring. In Nigeria, gas flaring remains a serious environmental issue of grave concern mostly to communities in the Niger Delta region where oil is being exploited. Ologunorisa (2001) reported that the Niger Delta region of Nigeria has suffered all forms of pollution and degradation arising from oil and natural gas exploitation. The study noted that in spite of laws which ban unauthorized gas flaring in the region, over 75% of the gas produced is still being flared which has had severe impacts on the physical, chemical, soil, biological, atmospheric and social environment.

The environmental impacts of gas flaring are borne by people in the area where it is being flared; as such, its impact is holistic because it affects farming activities, fishing and increases temperature thereby causing discomfort in relaxation and sleep routines. As a result of the persistent flare, farmers and individuals have diverse possible ways to manage the changes associated with gas flaring. For instance, many farmers practice delay planting and others carry out mixed planting among others as ways to adapt to the impacts of gas flaring. In some other areas or communities, households have to change occupations, mostly those affected by gas flaring, as a way to meet up with household income and needs. Others are pushed to change their economic activities. However, the adaptation measures adopted vary from one community to the other based on certain environmental factors and ways of life of the people as well as

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www.abjournals.org

socioeconomic factors. The apparently unending gas flaring and the inherent impacts have prompted numerous studies by scholars from different fields of human endeavor around the world.

However, in spite of the burgeoning body of literature on gas flaring, studies examining the adaptation strategies employed by communities around gas flares at varying distances is poorly documented in the literature of gas flaring. As expected, a large majority of the available studies essentially looked at the perceived environmental effects of gas flaring (Ndinwa et al., 2020; Abdulkadir et al., 2019; Udok & Akpan, 2017; Oseh et al., 2015; Esu & Dominic, 2013). Studying communities' adaptation strategies to gas flaring at varying distances is imperative because it enables precise adaptive measures to be put in place to adequately minimize the severity of impacts. This is so because communities close to gas flares are more likely to be seriously impacted by gas flares compared to those farther away from the gas flares as such, the adaptation measures required vary. The present study therefore assesses households' adaptation strategies to environmental changes induced by gas flaring at varying distances in Delta State, Nigeria, Nigeria. This study fills the gap in knowledge with respect to human adaptation strategies to changes induced by gas flaring.

METHODOLOGY

Study Area

The study area is Ughelli South, Ethiope East and Ughelli north LGAs of Delta State. The study area lies between latitude $5^0\,05^1$ and $5^0\,50^1$ north of the equator and longitude $5^0\,40^1$ and $6^0\,15^1$ east of Greenwich. The soil types are hydromorphic and alluvial (Erumere, 2016). The soils fall under the Sombreiro –Warri Deltaic Plain type and the Niger Delta flood plain type. The vegetation type is the lowland rainforest and the freshwater swamp forest. The climate of Delta state is tropical. It has a hot, humid equatorial climate. Temperatures are high and fairly constant throughout the year. Petroleum resources are the most important of these resources. Kokori (Erhoike) and Otu-Jeremi communities are major crude-oil bearing communities in the Niger Delta region of Nigeria (Erumere, 2016).

Research Design and Sampling Techniques

The experimental research design was employed. Purposive and systematic random techniques were employed to gather the data used for the study. Purposive and stratified techniques were used to select the sampling sites. Purposive sampling was employed to select only areas/communities where gas flaring is found, while stratified sampling was used to select the sampling locations into flare-impacted areas and non-flare-impacted areas. All the communities within 4km radius of the gas flare point were used for the study (Table 1). The sampling for the questionnaire distribution is the total number of estimated households in the study area. The 1996 projected population figures were used for this study instead of 2006 population figures. This is because the 2006 population figures for the different communities used for the study are not available. The 1996 projected population has the population figures for the communities used for the study. The average household size declared for Nigeria in the result of the National Population Commission 1995/1996 household survey is 4.48; this was used to divide the projected 1996 population of the study area (36,331) to get an estimated household number (7907) in the study area. A total of six hundred and thirty-eight (638)

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households were selected as the sample size. The sample represents 8% of the estimated households in the study area. Two field assistants and the researcher administered the questionnaires over a period of three months.

Table 1: Kokori (Erhoike) and Utorogun flow station and communities within 4 km radius

S/n	Communities	Distance from flare point (km)	1996 population projection	Number of households	Number of questionnaires administered	% of household sampled
1.	Erhoike	0.25	443	99	8	8
2.	Kokori	1.71	20,979	4,68 3	375	8
3.	Erho-obaro	3.21	462	103	8	8
4.	Okuenebiri	3.6	334	75	6	8
5.	Eranaka	3.82	201	45	4	8
6.	Avira	3.89	1,129	252	20	8
7.	Agbowhiame	1.71	266	59	5	8
8.	Umolo	1.79	1825	407	33	8
9.	Otu-Jeremi	2.08	2,956	660	53	8
10.	Eyara	2.72	1, 533	342	27	8
11.	Agbaghara	2.45	481	107	9	8
12.	Iwhrenka	3.35	2,118	473	38	8
13.	Imode	3.51	1,325	296	24	8
14.	Okpan	3.88	243	54	4	8
15.	Ovwodokpokpor	3.91	2036	254	20	8
	Total		36,331	7909	638	8

Source: *NPC, 1996*

Data Analysis

The sets of data obtained were statistically treated using tables, simple percentages and principal components analysis (PCA). Data obtained from the field on adaptation strategies to gas flaring were used as variable inputs for principal components analysis (PCA). PCA was performed using the SPSS package version 20.0 for Windows; components were extracted using the principal component analytical method and extraction of significant factors was done with a minimum acceptable eigenvalue > 1 (Kaiser, 1958; Gaur & Gaur, 2006), by using the Kaiser's criterion. Principal Component Analysis (PCA) was performed on 24 adaptation strategies data set in order to reduce redundancies of parameters and to identify the basic dimensions of the adaptation strategies employed in coping with the effects of gas flaring in Kokori and Otu-Jeremi and their environs respectively. The scores of rotated component loadings (correlation coefficients) from the PCA output were used to identify the main adaptation strategies. The rotated component loadings for the variables were determined using Varimax rotation; this approach makes interpretation and the identification of components easier (Shihab & AbdulBaqi, 2010; Shrestha & Kazama, 2007). Variables were also rotated to obtain new significant and uncorrelated variables called components. On each component, variables with loadings ≥0.60 were identified as significant variables and used for discussion of the data structure. Variables were also rotated to obtain new significant and uncorrelated variables, and thereafter, the number of components was reduced by eliminating relatively

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unimportant components with eigenvalues less than 1 as well as variables which loadings below the coefficient threshold of ≥ ±0.60.

RESULTS

Socioeconomic characteristics of respondents

The sex of respondents showed that 59.3% and 58.2% of the respondents in Kokori and Otu–Jeremi were males respectively; while 40.7% were females in Kokori and environs as compared to 41.8% in Otu–Jeremi and environs. It showed that 57.7 % of the respondents were 40 years and below in age in Kokori and its environs as compared to 44.1% in Otu–Jeremi and environs. In Kokori and environs and Otu–Jeremi and environs, 33.5% and 44.6% fall within ages 41-60 years respectively. In Kokori and environs and Otu–Jeremi and environs, 9.9% and 11.3% of the respondents respectively were above 60 years of age. This finding implies that most of the respondents are in their active, productive and reproductive age. On marital status, 57.3% of the respondents in Kokori and environs were married as compared to 60.6% in Otu–Jeremi and environs implying that the majority of the respondents are married.

The majority of the respondents in Kokori and environs (93.0%) had some level of formal education ranging from primary education to postgraduate educational qualification. About 31.6% had post-secondary educational qualification ranging from Ordinary National Diploma to first degree while 8.2% of the respondents had postgraduate educational qualification, while in Otu-Jeremi and environs, 28.6% had post-secondary educational qualification ranging from Ordinary National Diploma to first degree, while 12.2% had postgraduate educational qualification. The high literacy level of respondents means that they are able to give definite and precise information on the subject matter. Occupation results revealed that in Kokori and its environs, 1.4% of the respondents were involved in fishing, while 0.9% was involved in fishing in Otu-Jeremi and its environs. About 20% were involved in farming in Kokori and its environs, 18.8 % were involved in farming in Otu-Jeremi and its environs. While 18.8% and 18.3% of the respondents in Kokori, Otu-Jeremi and its environs were civil servants respectively. The remaining percentages were involved in trading/business, artisan activities, while others are students and the unemployed.

In addition, the monthly income of respondents showed that in Kokori and its environs, 7.0% of the respondents had no monthly income but they depend on their parents and relatives for survival, 15.9% had a monthly income of less than ₦10,000, 37.3% had a monthly income of between ₦10,001- ₦25000; 31.6% had a monthly income of ₦25001 - ₦40,000, while 8.2% had a monthly income of above ₦40,000. In Otu–Jeremi and its environs, 6.1% of the respondents had no monthly income; 38.5% had a monthly income of less than ₦10,000; 25.8% had a monthly income of between ₦10,001- ₦25000; 14.6% had a monthly income of ₦25001 - ₦40,000, while 15% had a monthly income of above ₦40,000. The income ranges of respondents in the two locations show basically low financial base and low-income earners. The length of stay of the respondents revealed that 59.5% of the respondents in Kokori and its environment have stayed in the area for 30 years and below, while 40.5% have stayed over 30 years; in Otu-Jeremi and environs, 65.6% have stayed for 30 years and below, while 37.6% have stayed for above 30 years.

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

Delayed planting of crops

Delayed planting of crops is an adaptation strategy used by the people in the study area (Table 2). In Kokori and its environs, 76.9% of the respondents agreed that they use delayed planting as an adaptation strategy to gas flaring, 11.6% of the respondents were undecided, while only 11.6% of the respondents disagreed that they use delayed planting as an adaptation strategy. In Otu-Jeremi and its environs, 71.8% of the respondents agreed that they delay planting as an adaptation strategy to gas flaring, 9.9% of the respondents were undecided, only 18.3% of the respondents disagreed that they use delay planting as an adaptation strategy.

Table 2: Delayed planting of crops

Options	Kokori and environs		Otu– Jeremi and environs	
	Frequency	Percent	Frequency	Percent
Strongly agree	127	30.6	62	29.1
Agree	192	46.3	91	42.7
Undecided	48	11.6	21	9.9
Disagree	32	7.7	23	10.8
Strongly disagree	16	3.9	16	7.5
Total	415	100.0	213	100.0

Increase land for crops production

The result in Table 3 showed that in Kokori and its environs, 28.2% of the respondents agreed strongly that they cultivate more land as an adaptation strategy to gas flaring. About 37.1% agreed that they should cultivate more land, 5.8% of the respondents were undecided, 19.3% of the respondents disagreed while 9.6% of the respondents disagreed strongly. In Otu-Jeremi and its environs, 25.4% of the respondents, agreed strongly that they cultivate more land as an adaptation strategy to gas flaring, 39% agreed that they cultivate more land, 6.1% of the respondents were undecided, 20.7% of the respondents disagreed while 8.9% of the respondents disagreed strongly.

Table 3: Increase land for crops production

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	Percent	Frequency	Percent
Strongly agree	117	28.2	54	25.4
Agree	154	37.1	83	39.0
Undecided	24	5.8	13	6.1
Disagree	80	19.3	44	20.7
Strongly disagree	40	9.6	19	8.9
Total	415	100.0	213	100.0

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Use of fast maturing varieties

As depicted in Table 4, use of fast maturing varieties of crops is an adaptation strategy employed by a good number of the farmers in the area. In Kokori and its environs, 35.4% of the respondents agreed strongly that they make use of fast maturing varieties of crops (cassava, yam) for planting as an adaptation strategy to gas flaring, 41% agreed that they also make use of fast maturing varieties of crops for planting as an adaptation strategy to gas flaring, 6% of the respondents were undecided, 13.7% of the respondents disagreed while only 3.9% of the respondents disagreed strongly. In Otu-Jeremi and its environs, 36.2% of the respondents agreed strongly that they make use of fast maturing varieties of crops for planting as an adaptation strategy to gas flaring, 39.9% agreed that they also make use of fast maturing varieties of crops for planting as an adaptation strategy to gas flaring, 4.7% of the respondents were undecided, 14.6% of the respondents disagreed while only 4.7% of the respondents disagree strongly.

Table 4: Use of fast maturing varieties

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	Percent	Frequency	Percent
Strongly agree	147	35.4	77	36.2
Agree	170	41.0	85	39.9
Undecided	25	6.0	10	4.7
Disagree	57	13.7	31	14.6
Strongly disagree	16	3.9	10	4.7
Total	415	100.0	213	100.0

Planting different species of crops

The information in Table 5 revealed that in Kokori and its environs, 20.7% of the respondents strongly agreed that they plant different species of crops as an adaptation strategy to gas flaring, 29.2% agreed that they also plant different species of crops as an adaptation strategy to gas flaring. About 8.9% of the respondents were undecided, 26.5% of the respondents disagreed while only 14.7% of the respondents disagreed strongly. In Otu-Jeremi and its environs, 21.6% of the respondents strongly agreed that they plant different species of crops as an adaptation strategy to gas flaring, 28.2% agreed that they also plant different species of crops as an adaptation strategy to gas flaring. About 9.4% of the respondents were undecided, 25.4% of the respondents disagreed while only 15.5% of the respondents disagreed strongly.

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Table 5: Planting different species of crops

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	**Percent**	**Frequency**	**Percent**
Strongly agree	86	20.7	46	21.6
Agree	121	29.2	60	28.2
Undecided	37	8.9	20	9.4
Disagree	110	26.5	54	25.4
Strongly disagree	61	14.7	33	15.5
Total	415	100.0	213	100.0

Shortening of growing season

Shortening of the growing season is an adaptation strategy used by the people in the study area (Table 6). In Kokori and its environs, 66.5% of the respondents agreed that they delayed planting as an adaptation strategy to gas flaring, 7.7% of the respondents were undecided, and while 25.7% of the respondents disagreed that they shortened their growing season as an adaptation strategy. In Otu-Jeremi and its environs, 62.9% of the respondents agreed that they shortened their growing season, 9.9% of the respondents were undecided, and while 27.2% of the respondents disagreed that they shortened their growing season as an adaptation strategy. Cultivation of crops such as yam and maize are delayed till January and February instead of November.

Table 6: Shortening of growing season

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	**Percent**	**Frequency**	**Percent**
Strongly agree	76	18.3	50	23.5
Agree	200	48.2	84	39.4
Undecided	32	7.7	21	9.9
Disagree	72	17.3	36	16.9
Strongly disagree	35	8.4	22	10.3
Total	415	100.0	213	100.0

Cultivation of varieties of crops/mixed cropping

Table 7 identifies cultivation of varieties of crops/mixed cropping as an adaptation strategy in the study area. In Kokori and its environs, 26% of the respondents strongly agreed that they cultivate varieties of crops/mixed cropping as an adaptation strategy to gas flaring. About 32.8% agreed that they also cultivate varieties of crops/mixed cropping as an adaptation strategy to gas flaring, 11.3% of the respondents were undecided, 17.3% of the respondents disagreed while only 12.5% of the respondents disagreed strongly. In Otu-Jeremi and its

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environs, 18.3% of the respondents agreed strongly that they also cultivate varieties of crops/mixed cropping as an adaptation strategy to gas flaring, 29.1% agreed that they also cultivate varieties of crops/mixed farming as an adaptation strategy to gas flaring, 7% of the respondents were undecided, 31.5% of the respondents disagreed while 14.1% of the respondents disagreed strongly. Examples of mixed cropping by farmers are planting cassava and okra, cassava and corn, yam and cocoyam, yam and corn.

Table 7: Cultivation of varieties of crops/mixed cropping

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	Percent	Frequency	Percent
Strongly agree	108	26.0	39	18.3
Agree	136	32.8	62	29.1
Undecided	47	11.3	15	7.0
Disagree	72	17.3	67	31.5
Strongly disagree	52	12.5	30	14.1
Total	415	100.0	213	100.0

Mulching

In Kokori and environs, 11.6% of the respondents, agreed strongly that they make use of mulching, 22.9% agreed that they also make use mulching an adaptation strategy to gas flaring, 13.7% of the respondents were undecided, 33% of the respondents disagreed while only 18.8% of the respondents disagreed strongly (Table 8). In Otu-Jeremi and its environs, 15% of the respondents agreed strongly that they make use of mulching, 27.2% agreed that they also make use of mulching as an adaptation strategy to gas flaring, 11.7% of the respondents were undecided, 30.5% of the respondents disagreed while 15.5% of the respondents disagreed strongly.

Table 8: Mulching

Options	Kokori and environs		Otu–Jeremi and environs	
	Frequency	**Percent**	**Frequency**	**Percent**
Strongly agree	48	11.6	32	15.0
Agree	95	22.9	58	27.2
Undecided	57	13.7	25	11.7
Disagree	137	33.0	65	30.5
Strongly disagree	78	18.8	33	15.5
Total	415	100.0	213	100.0

Change of occupation/economic activities

The result in Table 9 showed that most of the respondents in Kokori and its environs (78.5%) agreed that gas flaring causes change of occupation (livelihood). About 7% of the respondents

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were undecided, 10.4% of the respondents disagreed that gas flaring causes change of occupation while 4.1% of the respondents disagreed strongly that it causes change of occupation. In Otu-Jeremi and its environs, a greater percentage of the respondents (76.5%) agreed that gas flaring causes change of occupation (livelihood), 8.5% of the respondents were undecided, 9.9% of the respondents disagreed that gas flaring causes change of occupation while 5.2% of the respondents disagreed strongly that it causes change of occupation. About 35% of the respondents were engaged in farming, 25% were engaged in fishing, 15% were engaged in hunting while 5% were engaged in rubber and wine tapping.

A greater percentage of the respondents in both Kokori and its environs (78.5%) and Otu-Jeremi and its environs (76.5%) agreed that gas-flaring causes change of occupation of the local people. This shows that gas flaring has significant negative effects on the livelihood of the people of gas flaring communities in the Niger Delta region of Nigeria. The majority of the people interviewed have changed their occupation from farming, fishing, rubber and wine tapping to other occupations such as trading. Others combine farming or fishing with trading, telephone business, riding of commercial vehicles and motorbikes popularly known as Okada, especially the youths in the study area. In Kokori and its environs, 20% of the respondents have changed their occupation from farming to trading, 15% changed from fishing to trading while 37% of the respondents combine farming with trading. While in Otu-Jeremi and its environs, 25% of the respondents have changed their occupation from farming to trading, 24% changed from fishing to trading while 45% of the respondents combine farming with trading.

This finding is in line with Okoli (2006) who reported that farming, fishing and hunting which were the basic occupation of the people of Omoku in Ogba/Egbema/Ndoni L.G.A (ONELGA) have been partially abandoned as a result of dispossession of their lands by the oil companies operating in the area. Farming activities have been seriously affected and because of the destruction and despoliation of the soil ecology, there is a shift in the occupation of the people who now combine farming, hunting and fishing with other professions and other menial jobs to eke out a living as most of the forests have been stripped of their natural resources (plants depleted and animals migrated to different ecological zones).

Dimensions of gas flaring adaptation strategies in Kokori and environs

PCA of the 24 adaptation strategies/parameters resulted in 10 principal components (PCs) explaining 58.6% of the total variance in overall data set in Kokori and environs (Table 10). PC_1 had strong positive loadings on three variables; the variables are seasonal migration (0.840), delayed planting (0.768) and increased land for crop production (0.702). PC_1 was responsible for 8.1% of total variance and epitomized decline in soil fertility. The parameters on PC_1 as a result of their positive coefficients or loadings indicate increase in soil degradation. On PC_2, two variables loaded heavily and positively on it. The variables that loaded heavily on PC_2 were use of hat/face cap (0.701) and use of shade/glasses (0.698). The parameters that loaded on PC_2 revealed an increase in the use of heat protective devices; this component was responsible for 8.0% of the variance in the data set. PC_2 could be said to represent use of heat protective devices. On PC_3 only one variable loaded positively on it, the variable was bathing frequently (0.795) and it was responsible for 6.9% of total variance (Table 10). The only extracted parameter on this component indicated an increase in baths. PC_3 typified adaptation to heat. PC_4 which explained 5.2% of the total variance had strong positive loading on use of fast maturing varieties. As usual, the variable on PC_4 indicated fast maturing varieties. Hence, PC_4 represented the growing of fast maturing crop varieties. PC_5 explained 5.1% in the total

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variance and had one variable that loaded on it; the variable was sitting under a tree (another adaptation to heat) (0.716). PC_5 exemplified taking shelter under the tree. On PC_6, two variables, no knowledge of adaptation (-0.756) and planting different crop species (0.685) loaded negatively and positively on it. PC_6 represented knowledge of adaptation. The negative sign represents absence of adaptation knowledge, while the positive sign implies the reverse. PC_7 explained 5.1% in the total variance and had one variable that loaded on it; the variable was the use of a generator (0.774). PC_7 exemplified generator use. PC_8 explained 5.06% in the total variance and had two variables that loaded positively on it; the variables were the use of hand fan (0.654) and opening of windows and doors (0.638). PC_8 signified heat control. Finally, PC_9 and PC_{10} explained 4.99 and 4.98% in the total variance and had one variable each that loaded on them; the variables were sleeping outside at night (-0.822) and use of fertilizer (0.801). PC_9 and PC_{10} exemplified sleeping outside at night and soil fertility amendment respectively. The 10 extracted components therefore identify decline in soil fertility, use of heat protective devices, bathing frequently, growing of fast maturing crop varieties, taking shelter under the tree, knowledge of adaptation, generator use, heat control, sleeping outside at night and soil fertility amendment as principal adaptation strategies to gas flaring employed by the people in Kokori and environs.

Table 10: PCA result on adaptation strategies to gas flaring in Kokori & environs[a]

	Principal components									
	PC_1	**PC_2**	**PC_3**	**PC_4**	**PC_5**	**PC_6**	**PC_7**	**PC_8**	**PC_9**	**PC_{10}**
Seasonal migration	.840	.041	.006	-.007	.019	-.021	-.017	-.077	.012	.052
Delayed planting	.768	.012	-.115	.134	-.084	-.054	.087	-.181	.008	.113
Increase land for crop production	.702	.078	.072	.019	.105	.081	-.010	.123	.003	-.086
Use of hat/face cap	.087	.701	.066	-.058	.021	-.019	-.071	-.018	.010	-.145
Use of shade/glasses	-.025	.698	-.224	.033	-.096	.076	-.106	-.049	-.051	.071
It brings brightness (glare)	.022	.544	-.057	-.035	.107	.025	.188	.072	.007	.021
Restriction of movement at night	.065	.492	-.456	.159	-.069	.061	-.132	.007	.024	.246
Bathing frequently	-.012	-.098	.795	.048	.169	.077	.052	-.071	-.064	-.025
Rural-urban migration	-.008	-.090	.598	.063	-.025	-.112	.051	-.237	.045	.240
Use of fast maturing varieties	.123	-.056	.168	.714	-.019	-.081	.228	-.012	-.103	-.094
Mixed cropping	.032	.092	-.176	.571	.122	.019	-.403	.080	.188	-.041
Sitting under the tree	.044	.011	.157	.150	.716	-.009	.092	-.088	.003	.096
Use of electric fan	.141	-.078	.176	-.183	.493	.100	-.421	.259	-.037	-.001
Mulching	.098	-.111	.279	.328	-.459	.245	-.210	.123	.021	.169
No knowledge of adaptation	.031	.094	.154	.154	-.112	-.756	-.050	.051	.057	.031
Planting different crop species	.049	.237	.142	.130	-.168	.685	-.056	-.049	.091	-.034
Use of generator	.066	-.018	.116	.029	.127	.018	.774	.118	.039	-.033
Use of hand fan	-.065	-.095	-.060	.111	-.116	-.149	-.014	.654	.064	-.051
Opening of windows and doors	-.066	.170	-.198	-.095	.076	.057	.107	.638	-.087	.143
Sleeping outside at night	.110	.000	-.007	.069	-.085	.037	.054	.126	-.822	.126

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 110-124)

Irrigation	.163	-.163	-.025	.059	-.113	.089	.257	.281	.496	.072
Reduce growing season	.145	.333	-.050	.107	-.153	.029	-.077	.028	.432	.329
Use of fertilizer	.066	.027	.146	-.153	.042	-.089	-.026	.100	-.024	.801
Use of air conditioner	-.141	-.319	-.272	.291	.243	.154	.060	-.190	-.085	.427
Eigenvalues	**1.949**	**1.914**	**1.665**	**1.245**	**1.236**	**1.225**	**1.222**	**1.215**	**1.197**	**1.195**
% variance	**8.120**	**7.975**	**6.938**	**5.188**	**5.148**	**5.105**	**5.094**	**5.061**	**4.989**	**4.978**
Cumulative exp.	**8.120**	**16.095**	**23.033**	**28.220**	**33.369**	**38.473**	**43.567**	**48.628**	**53.617**	**58.595**

[a]the underlined coefficients are considered significant

Dimensions of gas flaring adaptation strategies in Otu-Jeremi and environs

Also, the PCA result of using 24 adaptation parameters extracted 10 components that explained 66.7% of the total variance in adaptation data set in Otu-Jeremi and environs (Table 11). PC_1 had four variables with positive loadings; the variables are sitting under the tree (0.843), bathing frequently (0.817), use of generator (0.703) and rural-urban migration (0.691). PC_1 accounted for 11.41% of total variance and symbolized heat wave mitigation. The parameters on PC_1 indicate increase in the strategies that help to control heat intensity as a result of their positive coefficients or loadings. On PC_2, two variables loaded heavily and positively on it (Table 11). The two variables that loaded heavily on PC_2 were use of face cap (0.934) and use of shade/glasses (0.926). PC_2 accounted for 10.0% of the variance in the data set and it signified use of heat protective devices. PC_3 also had two variables that loaded positively on it; the variables were irrigation (0.771) and planting of different crop species (0.753). PC_3 was responsible for 6.31% of total variance, and it typified water supply/planting different types of crops (Table 4). PC_4 which explained 6.30% of the total variance had strong positive loading (0.716) on seasonal migration. As usual, the variable on PC_4 indicated increased human migration. Hence, PC_4 represented seasonal migration. PC_5 explained 6.08% in the total variance and had two variables that loaded on it; the variables were reducing growing season (0.703) and opening of windows and doors (0.679). PC_5 exemplified planting of fast maturing crop varieties. On PC_6, two variables mixed cropping (0.700) and brightness (0.617) loaded positively on it. PC_6 represented planting of multiple crops. PC_7 explained 5.65% in the total variance and had one variable that loaded on it; the variable was the use of an electric fan (0.753). PC_7 exemplified use of electric fans. PC_8 explained 5.20% in the total variance and had only one variable that loaded positively on it; the variable was mulching (0.714). PC_8 signified mulching. PC_9 and PC_{10} explained 5.15 and 4.79% in the total variance and had one variable each that loaded on them; the variables were delayed planting (0.787) and use of hand fan (0.775). PC_9 and PC_{10} represented delayed planting and use of hand fans respectively. However, the 10 extracted components therefore are heat wave mitigation, use of heat protective devices, water supply/different types of crops, seasonal migration, planting of fast maturing crop varieties, planting of multiple crops, use of electric fan, mulching, delayed planting and use of hand fan as significant adaptation strategies employed by the people in Otu-Jeremi and environs.

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 7, Issue 3, 2024 (pp. 110-124)
www.abjournals.org

Table 11: PCA result on adaptation strategies to gas flaring in Otu-Jeremi & environs[a]

Variables	Principal components									
	PC_1	PC_2	PC_3	PC_4	PC_5	PC_6	PC_7	PC_8	PC_9	PC_{10}
Sitting under the tree	.843	-.038	.042	-.066	-.077	.023	-.061	-.043	.087	-.014
Bathing frequently	.817	.092	-.001	-.045	-.065	-.188	.027	-.044	-.081	.008
Use of generator	.703	-.092	-.074	-.096	-.064	.124	.112	-.107	.274	.034
Rural-urban migration	.691	-.157	.130	.097	.117	.037	-.012	.136	-.036	-.100
Use of hat/face cap	-.025	.934	.067	.047	.019	.104	.010	-.080	.036	.074
Use of shade/glasses	-.035	.926	-.020	-.011	-.136	-.033	.001	-.068	.017	.074
Restriction of movement at night	-.412	.551	.336	.121	-.008	.063	.108	.142	.004	.025
Irrigation	.192	.044	.771	-.062	-.256	.105	-.006	-.205	.056	-.037
Planting different crop species	-.048	.076	.753	-.193	.195	-.006	-.036	.084	-.089	.014
Seasonal migration	-.052	.052	-.110	.716	.112	-.193	-.157	-.031	-.032	-.141
Use of fertilizer	-.099	.029	-.214	.570	.011	.341	.139	-.246	-.213	-.116
Use of fast maturing varieties	-.017	.016	-.055	.565	-.168	-.043	.277	.252	.175	.195
Reduce growing season	-.022	-.189	-.136	-.020	.703	-.221	.052	.219	-.173	-.012
Opening of windows and doors	-.094	.037	.160	.160	.679	.304	-.026	-.088	.075	.282
Increase land for crop production	-.026	-.021	.015	.390	-.531	.204	.057	.236	-.234	.279
Mixed cropping	.047	-.049	.108	.043	-.065	.700	-.077	.045	.105	-.057
It brings brightness (glare)	-.124	.369	-.091	-.281	.030	.617	.099	.008	-.069	-.063
Use of electric fan	.047	.002	-.019	.016	-.031	.005	.753	.156	-.048	.156
No knowledge of adaptation	-.264	-.088	.037	.036	.004	-.218	.546	-.512	.225	.009
Use of air conditioner	.118	.253	-.025	.028	.109	.062	.504	.086	-.128	-.425
Mulching	-.105	-.102	-.042	.013	.041	.004	.185	.714	.153	-.024
Delayed planting	.059	.065	.047	.001	-.022	.009	.003	.206	.787	-.162
Sleeping outside at night	-.191	.032	.280	.073	-.024	-.165	.101	.226	-.474	-.240
Use of hand fan	-.039	.217	-.028	-.059	.106	-.113	.140	.002	-.114	.775
Eigenvalues	**2.739**	**2.400**	**1.515**	**1.512**	**1.461**	**1.381**	**1.356**	**1.249**	**1.235**	**1.150**
% variance	**11.412**	**10.000**	**6.314**	**6.298**	**6.087**	**5.753**	**5.648**	**5.203**	**5.148**	**4.792**
Cumulative exp.	**11.412**	**21.412**	**27.726**	**34.024**	**40.111**	**45.864**	**51.512**	**56.716**	**61.864**	**66.655**

[a]the underlined coefficients are considered significant

There are similarities between the components extracted in Kokori and its environs and Otu-Jeremi and its environs in adapting to gas flaring. The adaptation strategies adopted in both Kokori and Otu-Jeremi include the use of heat protective devices, growing of fast maturing varieties, heat control devices, bathing frequently, taking shelter under trees and seasonal migration.

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

CONCLUSION AND RECOMMENDATIONS

Gas flaring affects the environment, the socio-economic activities and health of communities**.** Gas flaring has contributed significantly to the recent environmental changes that have occurred in the Niger Delta region. These changes have been associated with widespread human suffering and societal disruption via environmental pollution and degradation. Though people have adopted some coping strategies, these have not yielded the desired results. Therefore, there is the need for both the government and the oil companies operating in these areas to take up the challenges of monitoring, assessing, evaluating, managing and developing the oil-producing areas through the provision of facilities especially infrastructural facilities such as schools, hospitals, markets, constant power supply, roads, potable water to help them cope with the changes induced by gas flaring for sustainable living and development. Improved irrigation infrastructures should be provided, as expansion of irrigation opportunities will reduce crop failures and facilitate productive farming activities in gas-flaring communities. The provision of fertilizers to these gas flaring communities by the oil companies and the government will help to improve their agricultural productivity since these people are mainly subsistence farmers. The Federal Government should provide improved seeds such as heat tolerant seeds to farmers in gas flaring areas. This will help to improve their agricultural productivity, thereby increasing their income and their standard of living. There is a need for the federal, state and local government to also provide information to people in these communities on what to do to cope or adjust to gas flaring. There is a further need to educate farmers on the benefits of using best farming practices available. The Niger Delta Development Commission (NDDC) could be involved in educating rural farmers in gas flaring communities.

REFERENCES

Odiong, A. U., O. O. Orimogunje, A. Ayanlade and T. A. Akinkwolie (2010). Perception of effect of gas flaring on the environment. *Research Journal of Environment and Earth Sciences* 2(4) 188-193.

Esu, B., and Dominic, O. (2013). Perceived effects of gas flaring on socio-economic well-being of farming households in Ogbia Local Government Area, Bayelsa State. *American Journal of Research Communication*, *1*(3), 27-34.

Udok, U., and Akpan, E. B. (2017). Gas flaring in Nigeria: Problems and prospects. *Global Journal of Politics and Law Research*, 5(1), 16-28.

Ndinwa, G. C., Akpafun, S. A., and Chukumah, C. O. (2020). Perceived Environmental and Health Impacts of Gas Flaring on Residents in Kwale Communities, Southern Nigeria. *Energy Review*, 4(1), 1-21.

Oseh, J.O., Oguamah, I.A., Oluwagbenga, O. O. and Adeyi, A. A. (2015). The environmental implication of gas flaring in the Sapele community of Delta State, Nigeria. *International Journal of Oil, Gas and Coal Engineering*, 3(5): 55-61.

Uyigue, E. and Agho, M. (2007). *Coping with climate change and environmental degradation in the Niger Delta of Southern Nigeria.* Community research and development center (CREDC) Benin, Nigeria. Benin: CREDC Press. pp: 45-62.

Abdulkadir, S., Abdullahi, A. C. and Bawa, H. S. (2019). Review of Nigeria's Effort to Stop Gas Flaring by 2020. International Journal of Strategic Research in Education, Technology and Humanities, 6 (1), 127 – 144.

Article DOI: 10.52589/AJENSR-3FPN217I
DOI URL: https://doi.org/10.52589/AJENSR-3FPN217I

Otiotio, D. (2013). Gas flaring regulation in the oil and gas industry: A Comparative Analysis of Nigeria and Texas Regulations, pp. 23–33. Available at: https://www.scribd.com/document/164743192/Gas-Flaring-Regulation-in-the-Oil-and-Gas-Industry-A-Comparative-Analysis-of-Nigeria-and-Texas-Regulations.

Ologunorisa, T. E. (2001). A review of the effects of gas flaring on the Niger Delta environment. *The International Journal of Sustainable Development and World Ecology*, 8(3), 249-255.